IV. THE FAUNA OF THE UPPER DEVONIAN IN MONTANA.

Part I. — The Fossils of the Red Shales.

By Percy E. Raymond.

In a paper "On the Occurrence in the Rocky Mountains of an Upper Devonian Fauna with Clymenia" in the American Journal of Science, Series 4, Vol. XXIII, p. 116, 1907, the writer announced the discovery by Mr. Earl Douglas of a fauna very similar to that of the *Clymenia* limestone of Germany. In that paper a preliminary list of the fossils found near Logan and Three Forks in the five zones of the Three Forks shale was given. The most novel of the fossils there listed were found in the red fissile shale of Zone 1 and it is these fossils which form the subject of the present paper. In later articles the more prolific faunas of the green shale and the limestone of Zones 2 and 4 will be described.

In a paper read before the Section of Palæozoölogy at the Seventh International Zoölogical Congress, but not yet published, the age of this fauna was discussed, and an attempt was made to show that it was younger than the fauna with *Manticoceras intumescens* in New York, Michigan, and elsewhere.

In the present paper nothing further than a description of the fauna of the red shale is attempted, further remarks on correlation being deferred until the Devonian faunas of the northern Rocky Mountains are more fully known.

Class BRACHIOPODA.

Order *TELOTREMATA* Beecher.

Family RHYNCHONELLIDÆ Gray.

Genus Camarotœchia Hall and Clarke.

Camarotœchia contracta Hall.[1]

(Plate III, figures 1–7.)

Atrypa contracta Hall, 1843. "*Report of the Fourth District, Geology of New York,*" p. 66, figs. 2, 3.

Rhynchonella (*Stenocisma*) *contracta* Hall, 1867. "*Paleontology of New York,*" Vol. IV, p. 351, pl. 55, figs. 26–39.

[1] For a full synonymy of the brachiopods listed in this article, see Schuchert, Bull. U. S. Geol. Survey, No. 87, 1897.

The identification of this shell is not entirely satisfactory, but the *Camarotœchia* which is so abundant in the Three Forks shale is more like this than any other described species. Some of the fully grown shells agree very closely with Hall's description in volume IV, "New York State Paleontology." They have about sixteen plications on each valve, three of which are in the sinus and four on the fold. Other specimens in the collection have one, two, or four plications in the sinus and two, three, or five on the fold.

Locality. — This is a common fossil in all the zones of the Upper Devonian with the exception of the white blocky shale. Nearly all the specimens from the red fissile shale are of small size. Three Forks and Logan, Montana.

Genus LEIORHYNCHUS Hall.

Leiorhynchus mesacostale Hall.

(PLATE III, FIGURES 8, 9.)

Atrypa mesacostalis Hall, 1843. "*Report of the Fourth District, Geology of New York*," p. 64, fig. 1.

Leiorhynchus mesacostalis Hall, 1867. "*Paleontology of New York*," Vol. IV, p. 362, Pl. 67, figs. 18–25.

This is one of the abundant fossils in this fauna. The specimens are moderately convex, transversely elliptical in outline, and usually of somewhat smaller size than the specimens from New York. The plications are entirely obsolete on the sides of most of the specimens, and the number of plications in the fold and sinus is variable, ranging from one to four in the sinus, and two to five on the fold. Half a dozen specimens have been observed which show one or two faint plications outside the fold and sinus.

Locality. — This species is common in the same zones as the preceding at Three Forks and Logan, Montana.

Family SPIRIFERIDÆ King.

Genus SPIRIFER Sowerby.

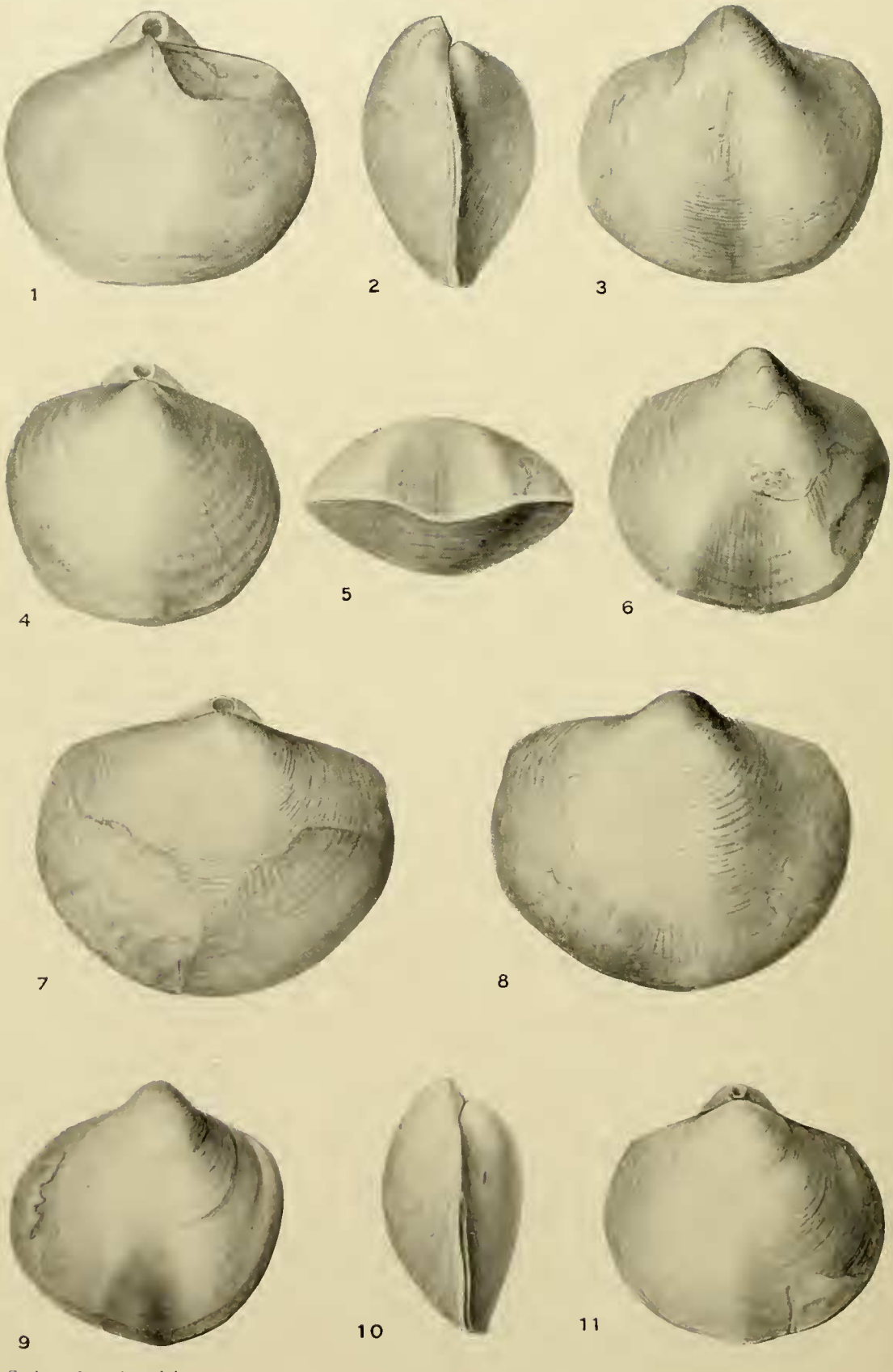
Spirifer disjunctus Sowerby.

(PLATE III, FIGURE 10.)

Spirifera disjuncta Sowerby, 1840. "*Transactions of the Geological Society*," 2d series, Vol. V, Pl. 53, fig. 8; Pl. 54, figs. 12, 13.

Spirifer disjunctus Hall and Clarke, 1893. "*Paleontology of New York*," Vol. VIII, pt. 11, Pl. 30, figs. 14, 15, 17.

This species is quite abundant in the red fissile shales, and is note-



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Cleiothyridina devonica Raymond.

worthy only for the small size of the specimens, which show all the characters of the adult.

Locality. — Logan, Three Forks, and elsewhere in Western Montana.

Spirifer pinonensis Meek.

(PLATE III, FIGURES 11, 12.)

Spirifer (*Trigonotreta*) *pinonensis* Meek, 1870. "*Proceedings Academy Natural Sciences of Philadelphia*," p. 60.

Spirifer pinonensis Walcott, 1884. "*Monograph U. S. Geological Survey*," No. VIII, p. 138, Pl. 4, figs. 1, 1*a*–1*e*.

A single well preserved specimen was found in the red fissile shale at Three Forks. The shell is robust, both valves being strongly convex. There are nine plications on each side of the fold and sinus, the first one on either side being stronger than the others. The fold shows a faint longitudinal indentation, and there is a trace of a plication in the sinus. The surface is marked by numerous fine concentric lines of growth.

Locality. — A very rare species in the red fissile shale of the Upper Devonian at Three Forks, Montana. It occurs more commonly in the limestone of the same region.

According to Walcott, this species ranges from the base to the summit of the Devonian limestone throughout the Eureka District in Nevada.

Genus AMBOCŒLIA Hall.

Ambocœlia gregaria Hall.

(PLATE III, FIGURES 13–15.)

Ambocœlia gregaria Hall, 1860. "*Thirteenth Annual Report New York State Cabinet Natural History*," p. 81.

Specimens of this species are fairly common and differ from the specimens found in New York only in their smaller size.

Locality. — Found in the Three Forks shale at Logan and Three Forks, Montana.

Family ATHYRIDÆ Phillips.

Genus CLEIOTHYRIDINA Buckman.

Cleiothyridina devonica sp. nov.

(PLATE III, FIGURES 16, 17; PLATE IV, FIGURES 1–11.)

Mr. Buckman has recently shown that the name *Cleiothyris* cannot be used for the group of shells usually so designated, as it was not so used by Phillips, the author of the genus. Mr. Buckman has there-

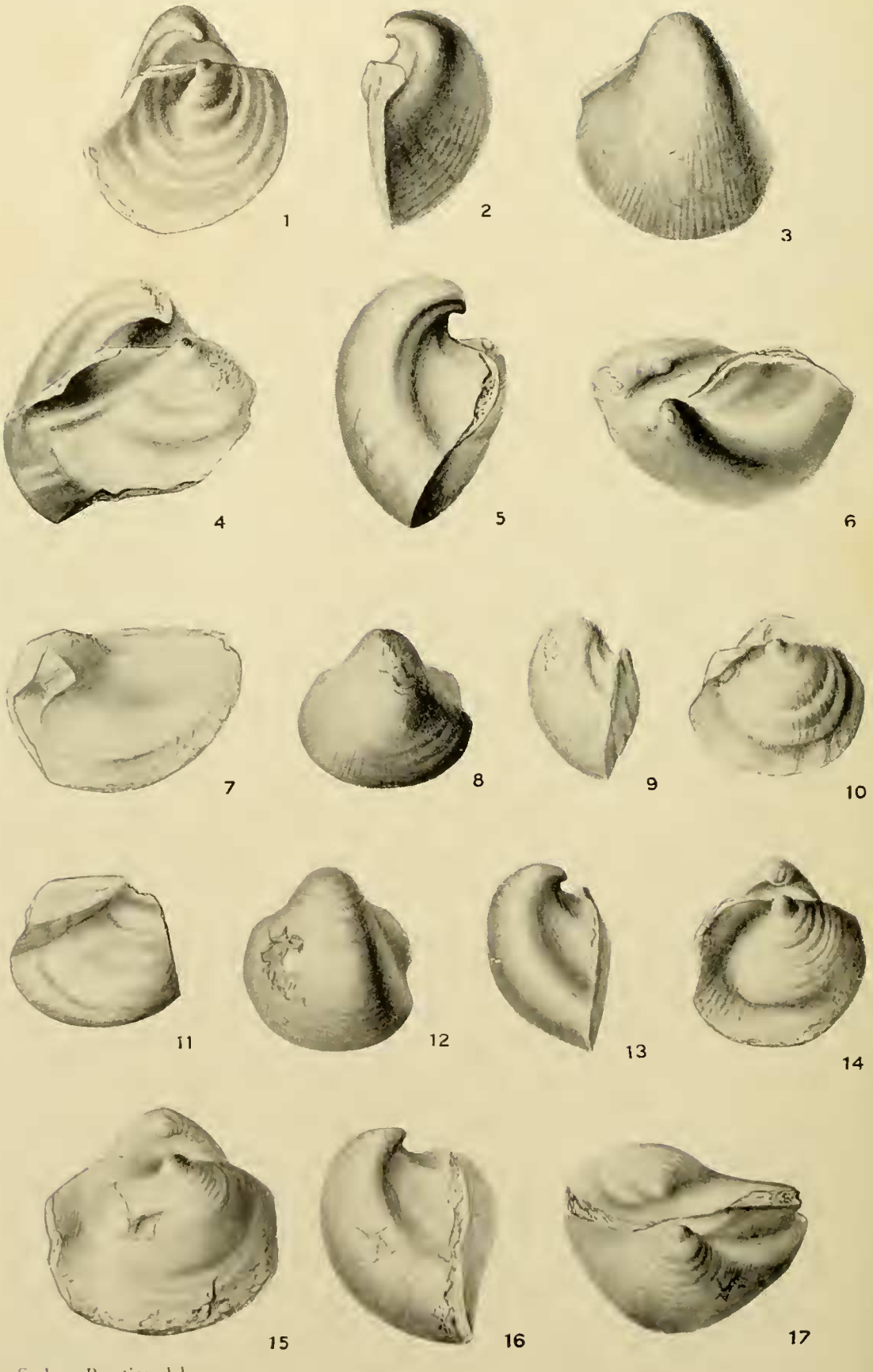
fore proposed the name *Cleiothyridina* and designated as the genotype *Athyris roissyi* as figured by Davidson, in the "Monograph of Carboniferous Brachiopoda," Pl. XVIII, fig. 8. (See Annals and Magazine Natural History, Series 7, Vol. XVIII, p. 321, 1906.)

Description.—The adult shell varies in outline from subcircular to transversely elliptical. The sides and front of the shell are usually somewhat straight, which gives the shell a rather quadrate form. The valves are nearly equally convex, the pedicle valve being slightly the deeper. The pedicle valve shows a narrow sinus or a flattened area in nearly all specimens, but in a few this valve is uniformly convex. On the brachial valve there is a low fold which is not defined at the sides and can be seen only when looking at the front of the shell. The beak of the pedicle valve is small and closely incurved, but the pedicle opening remains clear throughout life, the pedicle continuing to encroach upon the umbo as the beak becomes more incurved.

The surface markings on the better preserved specimens are those characteristic of the genus. The concentric lamellæ are very numerous and the spiniform extensions of their free margins are long and slender. Partially exfoliated specimens show fine, interrupted radial striæ, and casts of the interior show very numerous radiating vascular markings.

The spirals of a single specimen have been developed. They were replaced by hematite, while the interior of the shell was filled with calcite, thus permitting the use of acid. Each of the cones was found to taper rather rapidly outward and consisted of eleven turns of the flat lamella. The lamellæ were not fimbriated as Davidson found those of *Athyris pectinifera* Sowerby to be. Unfortunately the loop of this specimen was so distorted that its form could not be made out.

No other species of this genus are known from the Devonian, but several species have been described from the Mississippian and Pennsylvanian. The shell known as *Cleiothyris roissyi* L'Eveille is the most common of the Mississippian forms. Girty states that the shell as figured by L'Eveille is 34.5 mm. wide and 22.5 mm. long, deeply folded, with the two depressions which define the fold so deep as to give the shell a trilobate appearance. The beak is not incurved, so that the round, open foramen is a noticeable characteristic of the typical specimen. (See Monograph XXXII, U. S. Geol. Survey, pt. II, p. 570.) The shell thus described is very different from the one in the Mississippian usually identified as *Cleiothyris roissyi*, and



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Loxopteria holzapfeli and L. clarkei.

also very different from the Devonian shell here described. The Mississippian form should probably be known as *Cleiothyridina sublamellosa* (Hall) as Schuchert has already suggested in "Bulletin U. S. Geol. Survey," No. 87, p. 183, 1897. He says: "American specimens usually referred to this species are constantly smaller and are often without sinus or fold. If these differences are of sufficient importance to distinguish American specimens from typical *Cleiothyris roissyi*, then this species should be known as *C. sublamellosa* Hall."

From this Mississippian shell our specimens differ in their more transverse form and in the deeper sinus in the ventral valve.

The specimens of *Cleiothyridina devonica* are very well preserved and the great number of specimens in our collection exhibit a wide range of variation. In young stages the shell is subcircular in outline, becoming quite transverse and somewhat quadrate in the adult, while old shells show a tendency to regain the circular form. The history of the development of the sinus of the pedicle valve is similar. In young shells it is entirely absent. In the adult it is strongly developed, but in many old individuals it is practically obliterated. Individuals are found in which the development of one or both of these characters is retarded or accelerated. Thus there are small shells, especially in the red shales, with the deep sinus of the adult and the subcircular outline of the young and other specimens with the outline of the adult, but lacking the sinus.

Locality.— This is a common shell in most of the zones of the Three Forks shale of the Upper Devonian at Three Forks and Logan, Montana.

Subkingdom MOLLUSCA.

Class PELECYPODA.

Order *PRIONODESMACEA* Dall.

Family PTERINEIDÆ Dall.

Genus LOXOPTERIA Frech.

Loxopteria holzapfeli sp. nov.

(PLATE V, FIGURES 1–7, 11.)

Cf. *Avicula dispar* Sandberger. "*Versteinerungen des reinischen Schichtensystems in Nassau*," p. 284, t. 29, fig. 14.

Cf. *Kochia* (*Loxopteria*) *dispar* Frech, 1891. "*Die devonischen Aviculiden Deutschlands; Abhandlungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten*," Band IX, Heft 3, p. 77, t. 6, figs. 4–4*h*.

Cf. *Loxopteria dispar* Clarke, 1903. "*The Naples Fauna in Western New York*; *Memoir of New York State Museum*," No. 6, p. 272, Pl. 13, figs. 8–17.

Description. — Shell somewhat triangular in outline, inæquivalve, the right valve nearly flat, the left valve capuliform.

The right valve is slightly convex, sometimes quite flat. A narrow sulcus extends from the beak to a notch in the posterior margin of the shell, and delimits a wing-like portion of the valve. There is no posterior gape observable in any of the shells in the collection, but the thin margins of the "ears" are frequently broken.

The left valve is strongly elevated and acute in the umbonal region, but the beak is incurved almost to the hinge. The anterior end of the valve is smoothly rounded, the length of the hinge being less than the length of the shell. From the highest point on the valve to the anterior margin the slope is gradual, but the posterior slope is abrupt and slightly concave. This concavity is broken by a ridge which extends from the posterior side of the beak to a rounded, ear-like extension of the posterior margin of the valve.

The surface of both valves is marked by numerous fine, radiating striæ. The right valve also shows a few rather strong concentric undulations.

No muscle scars have been observed on the left valves, but some of the better preserved casts of the interiors of right valves show a small but strong oval posterior scar and an apparently entire pallial line. An anterior muscle was undoubtedly present, but its scar has not been detected on any of the specimens at hand.

The prodissoconch is retained on both valves, and is set off from the remainder of the beak by a shallow groove. Its position shows a clock-wise tortion of the shell during growth.

The ligament was external. The ligamental area on the left valve is triangular, with the apex of the triangle directly beneath the beak. On the right valve the greater part of the ligamental area is posterior to the beak, and its plane is at an angle of about 45 ° to the remainder of the valve. No striations were observed on the ligamental area.

This species seems closely allied to *Loxopteria dispar* (Sandberger), as described by Frech, but differs from that species in having the wing of the right valve more sharply defined and in the ornamentation of the same valve by strong concentric undulations.

From *Loxopteria dispar* as described by Clarke from specimens obtained in western New York, our specimens differ in having a small

ear on the posterior end of the left valve, a ligamental area under the umbos, concentric ridges on the right valve, and in the absence of broad radial ribs, and of a posterior opening between the shells. In surface markings, disregarding the concentric wrinkles on the right valve, our specimens agree best with figures 4*b* and 4*d*–4*f* of the illustrations in Frech's work cited above, while Dr. Clarke's specimens seem to agree best with figures 4*c*, 4*g* and 4*h*. *Loxopteria corrugata* Clarke and *L. rugosa* Frech are species with pronounced concentric wrinkles on the right valve, but neither of these species has a sharply defined posterior wing.

This species is named for Professor Eduard Holzapfel, of Aachen, whose researches have greatly extended our knowledge of the Upper Devonian faunas.

Locality. — This species is common in the red fissile shale of the Upper Devonian at Three Forks, Montana. It occurs more rarely in the limestone above the red shale at the same locality.

Loxopteria clarkei sp. nov.

(PLATE V, FIGURES 8–10, 12–17.)

Cf. *Kochia* (*Loxopteria*) *lævis* Frech, 1891. "*Die Devonischen Aviculiden Deutschlands; Abhandlungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten*," Band IX, Heft 3, p. 76, t. 6, figs. 3–3*e*.

Just as *Loxopteria holzapfeli* is closely related to *L. dispar*, so the other species of *Loxopteria* found in the same fauna is very similar to *L. lævis* Frech. The shell may best be described by comparing it with the species of this genus already known. Both valves are convex, there being much less disparity between them than in *L. holzapfeli*. From that species it differs also in having a less highly elevated and more rounded umbonal region, a less acute and prominent beak and in the possession of concentric undulations on both valves.

From *Loxopteria lævis* it differs in having a more pronounced posterior wing on both valves, a less depressed beak on the left valve, and in the presence of concentric undulations on both valves.

Dr. Clarke has referred to *Loxopteria lævis* specimens which, as that author remarks, differ considerably from the German specimens in having a depressed right valve and concave larval shell. None of the shells from Montana show these characters.

This shell is named for Dr. John M. Clarke, to whom we are indebted for our knowledge of the fauna of the Middle Upper Devonian of America.

Locality. — This is a rather rare species, and has been found only in the red fissile shale of the Upper Devonian at Three Forks, Montana.

Family MODIOLOPSIDÆ Fischer.

Genus GONIOPHORA Phillips.

Goniophora subrecta Hall ?

(PLATE VI, FIGURES 1–3.)

Goniophora subrecta Hall, 1885. "*Paleontology of New York*," Vol. V, pt. 2, Vol. II, p. 304, Pl. 42, figs. 14, 15; Pl. 44, figs. 19, 21.

To this species is referred with considerable doubt a shell which is very common in all but one of the zones of the Upper Devonian in the vicinity of Three Forks, Montana. The specimens differ from those described by Hall in having a somewhat longer hinge, a more nearly square posterior end, and a more rounded anterior margin. The specimens from the red shale are all much smaller than those obtained from the limestone and the green shale.

Class CEPHALOPODA.

Subclass **TETRABRANCHIATA.**

Order *NAUTILOIDEA.*

Family ORTHOCERATIDÆ Hyatt.

In the fauna obtained from the red shales there are several species of straight-shelled nautiloids, represented in large part by small fragments of the chambered portion of the shells. Three of these forms are sufficiently abundant and represented by enough material to make them worthy of description. All are circular in section, with smooth surface, small, slightly eccentric siphuncles, and short siphuncular collars. While the material at hand is hardly sufficient to render the generic reference certain, yet it seems very probable that they belong to the family Orthoceratidæ as defined by Hyatt, and that one of them is an *Orthoceras*, while the other two have the very small siphuncles of *Geisonoceras*.

Genus ORTHOCERAS (Breyn.) emend. Hyatt.

Orthoceras montanense sp. nov.

(PLATE VI, FIGURES 4–6.)

This species is known only from fragments, none of which are large. The shell is circular in section and tapers very gradually. The

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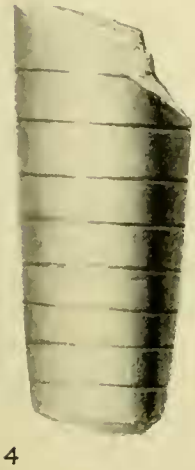

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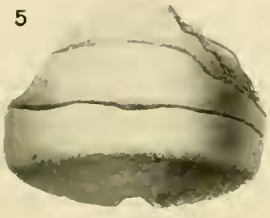

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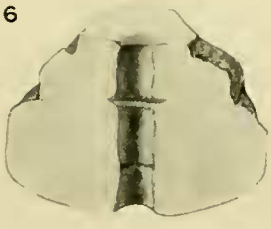

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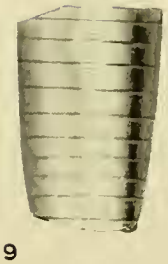

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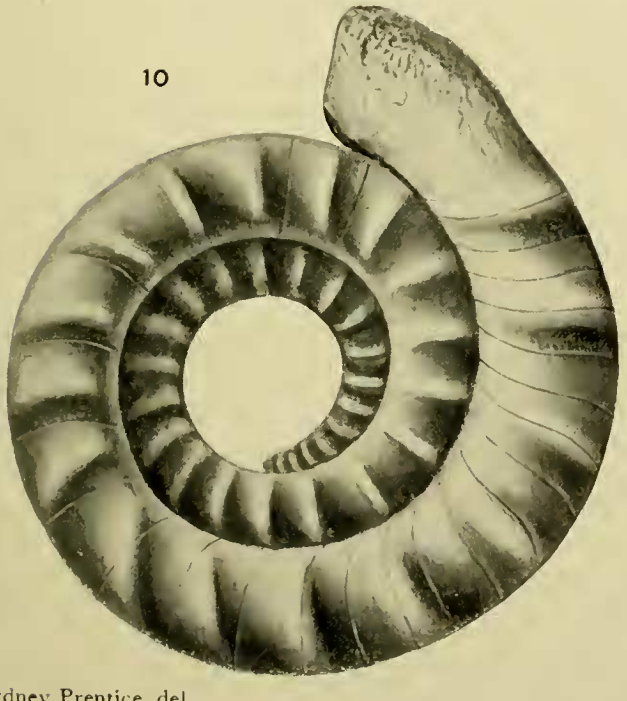

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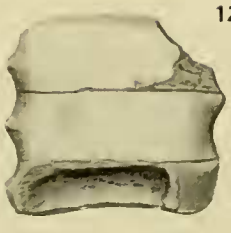

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Upper Devonian Cephalopoda and Pelecypoda.

cameras are shallow, there being seven in a length of 16 mm. The sutures are nearly straight, the septa strongly convex. The siphon tube is 1.5 mm. in diameter where the shell is 14 mm. in diameter and has the same measurement at the smaller end of another specimen where the shell is 7 mm. in diameter. The siphuncle is slightly off the center of the shell, but whether dorsad or ventrad cannot be determined. No specimen in the collection shows any part of a living chamber that can be referred to this species.

The specimens are replaced by hematite and pyrite and are not crushed. One of the specimens sectioned shows the short siphonal funnels very well as the siphuncle contained only a very soft clay which was easily removed. All the other specimens sectioned were entirely filled with the hematite and the siphon tube could not be distinguished.

Locality. — This species is rather common in the red fissile shale of the Upper Devonian at Three Forks, Montana.

Genus GEISONOCERAS Hyatt.

Geisonoceras normale sp. nov.

(PLATE VI, FIGURE 7.)

Shell small, gradually tapering, circular in section. The living chamber is preserved in one specimen, and is about as long as eight cameras and apparently comprises one third of the shell. None of the cameras are deep, but they become more shallow on approaching the living chamber. On the best specimen the three cameras nearest the living chamber together occupy a length of only 3 mm., while the next three occupy 5 mm. The sutures are almost straight, the septa moderately convex, the siphon tube very small, and the siphonal funnels very short and delicate. The position of the siphuncle seems to be somewhat variable. In some specimens it is almost central, while in others it is nearly half way between the center and the margin.

This species may be distinguished from the last by its much smaller size, shallower cameras, smaller and more eccentrically placed siphuncle.

Locality. — This species is rather common in the red shale of the Upper Devonian at Three Forks, Montana.

Geisonoceras accelerans sp. nov.

(PLATE VI, FIGURES 8, 9.)

This species is very similar to the last, differing from it principally

in the shallower cameras. As may be seen by the figured specimen the older cameras are nearly as deep as those in *Geisonoceras normale*, but on approaching the living chamber they become very shallow. The siphuncle is very small, and is situated close to the center. Living chamber and siphonal funnels not seen. A few specimens show traces of faint longitudinal striæ.

A specimen of this shell was sent to Dr. Holzapfel, who compared it, on account of its very shallow cameras, with *Orthoceras gregarium* Münster (*O. angustiseptatum* Gümbel).

Locality. — This species occurs rather rarely in the red shales of the Upper Devonian at Three Forks, Montana.

Order *AMMONOIDEA.*

Suborder *GASTROCAMPYLI* Hyatt.

Family CLYMENIDÆ Gümbel.

Genus PLATYCLYMENIA Hyatt.

Platyclymenia americana Raymond.

(PLATE VI, FIGURES 10–13; PLATE VII, FIGURES 1–3.)

Clymenia (*Platyclymenia*) *americana* Raymond, 1907. "*American Journal of Science*," series 4, Vol. XXIII, p. 118, figures.

This is by far the most abundant of the cephalopods in the red fissile shale and is also quite common in the green shale. Although a great number of specimens have been collected, most of them are so poorly preserved that they are useless for study.

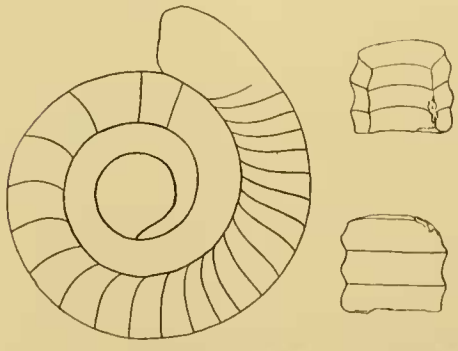
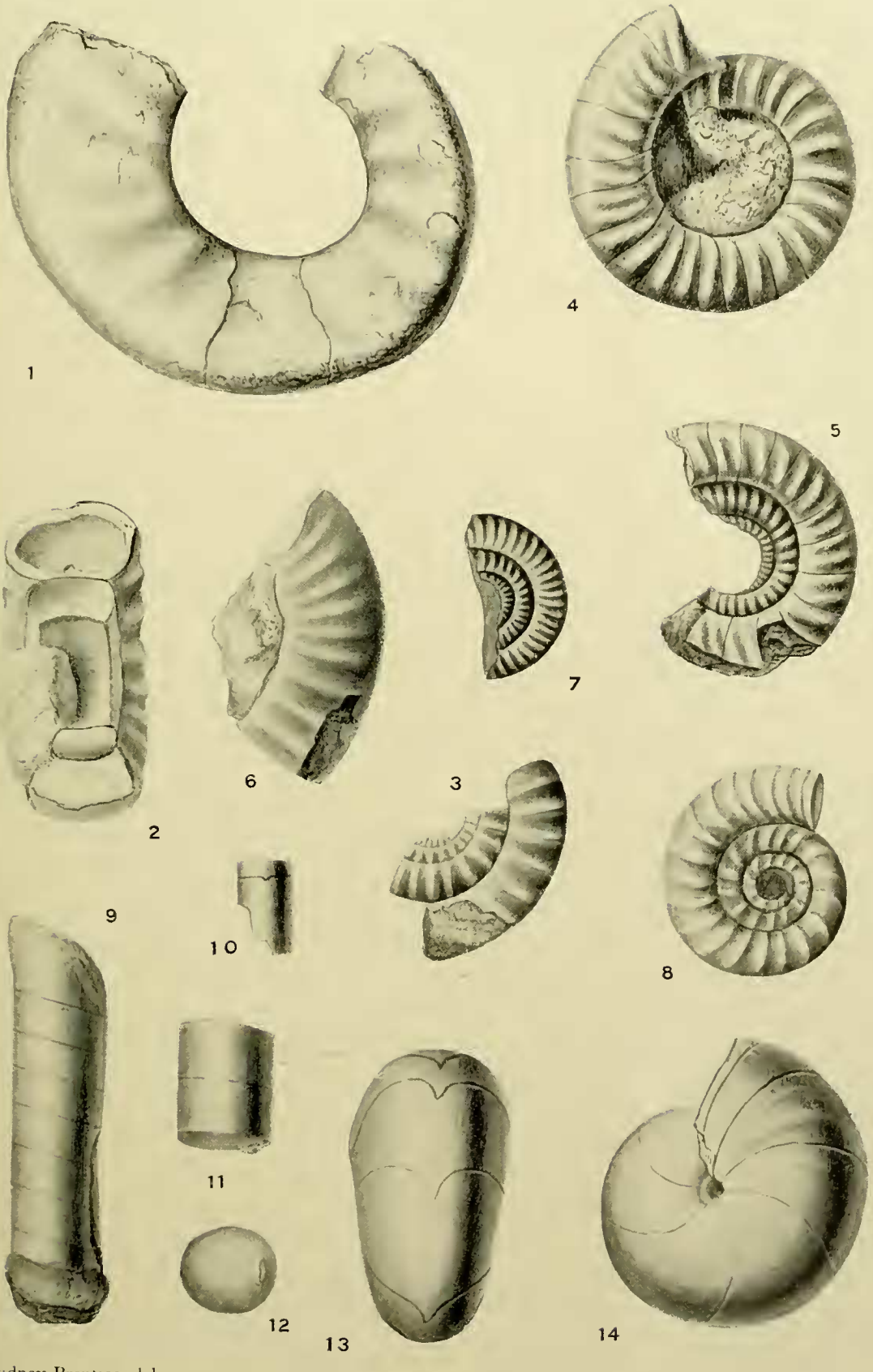


FIG. 1. *Platyclymenia americana* Raymond. Outline drawing of the type and of a fragment to show sutures. Natural size.

Description. — Shell of medium size for the genus, compactly coiled, but not involute. The whorls are depressed in section, the venter of the inner whorls flattened, that of the living chamber more convex. The living chamber is large, consisting of over half a volution. The cameras are rather shallow on the inner whorls, become deep in the adult, and then suddenly become so shallow that the septa are twice as numerous as before. The sides of the whorls are crossed by strong ridges which have a slightly diagonal trend and which die out on the umbilical margin and on the



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Upper Devonian Cephalopoda.